recognition during his life in the bestowal of degrees by higher institutions of learning; in election to membership in nearly all scientific societies worthy of note in Europe and America; in being made the recipient of medals of honor awarded by these societies, and in the generously expressed words of his distinguished contemporaries. It will be many years, however, before full measure can be had of his influence in promoting the interests of physical science, for with his own brilliant career, sufficient of itself to excite our profound admiration, must be considered that of a host of other younger men who lighted their torches at his flame and who will reflect honor upon him whose loss they now mourn, by passing on something of his unquenchable enthusiasm, something of his high regard for pure intellectuality, something of his love of truth and his sweetness of character and disposition.

T. C. MENDENHALL.

REPORT OF THE BOARD OF VISITORS TO THE NAVAL OBSERVATORY FOR THE YEAR 1901.

IN pursuance to a call issued by the Secretary of the Navy, a meeting of the Board of Visitors to the Naval Observatory was held in Washington, beginning April 9, 1901. The Board was organized by the selection of Charles A. Young as chairman and Ormond Stone as secretary. Another meeting was held in Washington, beginning October 29, 1901. At both of these meetings, and afterwards by correspondence, as careful an examination as time permitted was made, directly and by committee, of the condition and needs of the Observatory, and of such other matters as are referred to in the law creating the Board. In this examination the Board was greatly aided by conferences with the Secretary of the Navy, the Superintendent and staff of the Naval Observatory, officers of the Civil Service Commission, and others, all of whom have given the Board their most cheerful assistance. As a result of the deliberations of the Board the following recommendations are respectfully offered for consideration:

ASTRONOMICAL DIRECTOR.

It is recommended that no astronomical director be appointed at present, as a dual headship has been found to work unsatisfactorily, and under the existing law the appointment of an astronomer as sole director of the Observatory—which the Board considers the proper solution of the question—is impracticable.

METHOD OF FILLING VACANCIES.

Vacancies should not be filled among assistant astronomers nor among professors of mathematics in the Navy without examination for each vacancy occurring. For example, the results of a given examination should not be used for filling a subsequent vacancy, except in so far as such results may properly form a part of a new independent examination. No distinction should be made between employees of the Observatory and other applicants. Employees should, however, of course, be at liberty to present evidence of experience or capacity as shown by their work at the Observatory in the same manner as other candidates present similar evidence as shown by their work elsewhere. The responsibilities of the positions of assistant astronomer and professor of mathematics are distinctly different from those of a computer, although much of the required experience may properly be gained in connection with the latter position and be credited in the examinations for the higher positions. At the same time it is important that the positions of computer should be filled by persons whose prime interest is in practical and theoretical astronomy and whose ambition it will be to occupy higher positions in the Observatory. As far as is

consistent with the routine needs of the institution, the duties of the computers should be so arranged as to encourage them to prepare for advancement within the Observatory itself. The positions of piece-work and of regular computers are essentially of the same nature, and promotion from one of these grades to the other may very properly be made, but always on the basis of merit rather than length of service. In no case should appointments be made to the Observatory merely by transfer from other bureaus or offices in the service, nor should appointments ever be made even temporarily without competitive examination.

ASSISTANT ASTRONOMERS.

In accordance with the principles herein stated, instead of recommending the name of a person to fill the vacancy now existing among the assistant astronomers at the Naval Observatory, we recommend that an examination be held with the assistance of the Civil Service Commission, in accordance with an announcement, a copy of which accompanies this report as Exhibit A, the examiners to be the members of the Board of Visitors for the time being. In order to carry this out, it is requested that Departmental Order No. 14 be so modified that employees of the Naval Observatory may have the same right to apply as other persons.

ADMINISTRATION OF THE OBSERVATORY.

We desire to call attention to the fact that the enactment which created the Board of Visitors provides that "the Superintendent of the Naval Observatory shall be, until further legislation by Congress, a line officer of the Navy of a rank not below that of captain," thus implying that a change in the law is in contemplation. As every other prominent observatory is under the direction of an astronomer, we wish to record our deliberate and unanimous judgment that the law should be changed so as to provide that the official head of the Observatory—perhaps styled simply 'the director'—should be an eminent astronomer appointed by the President, by and with the advice and consent of the Senate, holding this place by a tenure at least as permanent as that of the superintendent of the Coast Survey, or the head of the Geological Survey, and not merely by a detail of two or three years' duration. Only in this way can there be a continuous and effective policy of administration which will insure astronomical work of a high order. In rank, salary, privilege and prestige he should be superior to any other official on the ground.

The limitation in the selection of assistants should also be removed, and the assistant once appointed should be secure against detachment or removal except by the action, for cause, of the director.

The institution should be related to the Navy Department, if continued under its control, in some such way as the Royal Observatory at Greenwich is related to the British Admiralty. It should be put under the control of the Secretary directly, and not through a bureau as at present.

SCOPE AND PLAN OF WORK.

The relation of the United States Naval Observatory to astronomy is unlike that of any other observatory in the country. A private observatory is usually devoted to a special line of work selected by its director, or by the head of one of its departments. This work is then carried on in the manner and in the special directions chosen by the officer in charge. The Naval Observatory, on the other hand, is maintained at the expense of all the people of the United States, and its work should not be entirely determined by the wishes and interests of any one individual; a principal use should be to supply the wants of astronomy by undertaking researches which have been

neglected elsewhere, either because they are too expensive or for other reasons. It is believed that the policy of undertaking neglected work, and doing what is most needed and not what is most attractive, would commend itself to Congress, to astronomers and to the people.

The Naval Observatory should cooperate with the other observatories of the country, use its influence to prevent needless duplication of work, and supply important deficiencies in work done elsewhere.

Great care should be taken in preparing a permanent scheme of work in the preparation of which the opinions of experts in each department should be carefully considered.

Important changes in such a plan should be made only after careful consideration, and should in general relate to details of observation, reduction and form of publication, rather than to objects or classes of investigation. The officers required to carry out this work should be selected for special fitness or experience, as well as for general astronomical knowledge, and a change in duty should be seldom made and then only for important reasons. If any observer has by years of experience attained great skill with a meridian circle, to place him in charge of an equatorial would be much like making a sailing master of an engineer, however skilled he may be. Great care should be taken in the assignment of duties to different members of the observing staff in order to secure a satisfactory distribution of force among the instruments and to avoid undue concentration or the reverse. At the same time the special aptitudes of individuals should be kept in mind, and their interest enlisted by giving them as far as possible independence of responsibility.

The following provisional plan is suggested for criticism and amendment:

The meridian circle is necessarily one of the most important instruments in a government observatory. Daily observations should be made, whenever possible, of the sun and moon, and of sufficient number of standard stars to determine accurately the error of the standard clock and the constants of the instrument. The major planets should be observed on a certain number of nights every year to correct their ephemerides, but not often enough to curtail seriously the other work of the instrument. A system of standard stars should be selected by cooperation with the various national almanacs and observatories, and a certain number of observations of each of these stars should, if possible, be secured each year. In planning the observations, the determination of their absolute and not merely their relative positions should be taken into consideration. In preparing a list of standard stars it is suggested that instead of attempting to observe all stars brighter than a given magnitude, it might be better to take only those of about the same magnitude and spectrum, in order to eliminate errors due to magnitude and color, and to choose those nearly equally spaced in the sky, adding such polar and equatorial stars as will culminate at nearly equal intervals and will not interfere with one another. It would also be necessary to include all the very bright stars as a basis for daylight observations. As examples of special researches that might have been taken up under such a system may be mentioned the comparison stars for Victoria and Sappho proposed by Dr. Gill in 1889, and the comparison stars selected by the Astrophotographic Conference of 1900 for observations of Eros.

The altazimuth instrument should perhaps also be used for observing the moon when off the meridian, and for determining the time when clouds render it impossible to observe on the meridian. The observation of zenith stars should be continued

with the prime vertical instrument and vertical circle. These observations, which appear to be of a high degree of excellence, have now lasted eight years, and should be maintained for at least eleven years longer, or through a complete metonic cycle, to furnish a good determination of the constant of nutation. An additional computer is much needed for the reduction of this work.

The determination and distribution of accurate time will always be an important function of a government observatory, and requires a careful administration. Not only is the exact time required for rating the chronometers of the Navy, but at present time signals are distributed by telegraph from the Naval Observatory throughout the country. The value of accurate time to the people generally is so great that no reasonable effort should be spared to reduce the inevitable errors from every source as much as possible. Formerly large sums were expended by railroads, cities, factories and makers of clocks and watches in the purchase of time signals, furnished by various observatories. To many observatories this was an important source of income.

In 1883 the astronomers of the country, recognizing the great value of a system of uniform standard time, used all their influence toward securing its adoption, notwithstanding the obvious danger to their private interests—since under such a system it would be possible for a single institution to furnish time to the whole country. In fact, in 1891 the Naval Observatory assumed the task. While the time as now distributed from the Observatory is sufficiently accurate for most business purposes, since a nonaccumulating error of a few seconds is of little importance in that view, it appears, however, that at considerable distances from Washington the errors are often considerably greater than under the old system, when the time was communicated from a standard clock not very far away, the errors being often large enough to interfere with the utility of the signals for chronometer rating and scientific purposes. The difficulty lies largely in the methods by which the time is transmitted by the telegraph, but more in the slightly irregular rate of the standard clock through long intervals of cloudy weather during which star observations cannot be obtained.

It would seem that by cooperation with other observatories a considerable improvement might be made, by arranging matters so that every night, or at least on nights during which the weather is bad at Washington, these observatories should each send a time signal to the Naval Observatory, indicating also the interval since the last observation.

It is difficult to see any way in which the efficiency of the Navy is increased by means of the 26-inch equatorial telescope. If left idle, however, it would be a subject for severe criticism, owing to the large sums of money already expended upon it. Its work should, therefore, be planned wholly in the interests of astronomy. The same principle should be adopted as with the other instruments. Researches should be undertaken which have been neglected at other observatories, duplication of work should be carefully avoided, and no investigation should be undertaken that can be done equally well with smaller instruments. The following examples of the species of work to be undertaken may be mentioned: A list of double stars which are too difficult to be observed with small instruments, and of which no recent accurate measures have been made, should be prepared with the advice of specialists in this department, and measured with the greatest accuracy; binaries and suspected binaries should, of course, receive special attention; neglected

asteroids and variables should similarly be followed; the observations of the satellites should be continued with this instrument, especially those of Saturn and Uranus, which are likely to be neglected at European observatories for the next few years owing to their southern declinations.

Lost asteroids, and perhaps others, can best be found and followed by photography. The spectroscopic approach and recession of the stars is at the present time under investigation with so many very large telescopes that this work may be left to them. The number of known spectroscopic binaries, however, is so great that it may be necessary hereafter to follow them carefully to determine the laws governing their motions. The work of the 12-inch equatorial should supplement that of the 26-inch.

In general the plan of work should be altered but rarely, and then only when changes seem imperative. Special attention should be given to work neglected elsewhere, and every effort made to render our knowledge of astronomy as complete as possible.

AMERICAN EPHEMERIS AND NAUTICAL ALMANAC.

Among the most important scientific publications of the Government of the United States are those issued by the Office of the American Ephemeris and Nautical Almanac. The first and best known is the Almanac issued every year, which gives name to the office. Four European countries—Great Britain, Germany, France and Spain—make similar publications, and a great saving might be effected by carrying still further the plan of cooperation already in part adopted. To avoid errors certain elements are computed independently three times, but if this is done for all five of the almanacs evidently much work is wasted. So far as possible the same quantities should be published in all of the almanacs, and computed independently as many times as may be deemed necessary. Ninety-six pages are devoted to that important and laborious problem, the exact path of the moon. Here an independent computation seems needless when we consider that the only American observatory at which the position is regularly determined is at Washington. The occasional observations made at other places have, in general, but little permanent value, and for observations of the moon at sea far less accurate positions are needed. In fact, 72 additional pages are devoted to lunar distances. In order that the saving suggested may be accomplished without delaying the publication of the Almanac, arrangements should be made with the foreign almanac offices to complete their computations at least a year longer in advance than is done at present.

A second most important consideration is that changes should be made only after a most careful examination and consultation with astronomers for whose benefit the Almanac is printed, and with the approval of the Board of Visitors. Changes not only cause great inconvenience, but often render it necessary to employ some other almanac when reducing the observations extending over a long period of years. The changes suggested below are so extensive that they should be made only if approved by American astronomers in general.

Washington mean time is not used even at Washington, and its use in the Almanac seems superfluous. Greenwich mean time, as modified in standard time, is in universal use in the United States, and is already used in a large part of the Almanac. Central time, which differs from Greenwich time by exactly six hours, might be conveniently used to simplify the interpolation for the transits of the moon and planets.

The phase angle, i, should be given for

the outer planets as well as for Mercury and Venus.

The ephemerides of the satellites are often insufficient for even the identification of these bodies. This is particularly the case with Hyperion and Iapetus. For the latter even the apparent ellipse is not given. It will probably not be necessary to return to the bulky tables of the satellites of Jupiter, published yearly in the Almanac before 1882. It would be convenient to have the correction to the ephemeris given when it is known—for instance, the ephemeris of Mimas for this year (1901) is in error by about four hours. Accordingly it is invisible on account of the ring at the predicted times of elongation.

The published positions of observatories should be changed only after careful consultation with the directors. If a system of longitude like that of the Coast Survey is adopted, it should be so stated in the description. The statement that 'the latest available data have been used' is too indefinite.

A great saving in expense might be effected by the adoption of some of the changes mentioned above. This would permit the insertion of valuable data now omitted. For instance, the list of star places might be greatly extended, ephemerides for physical observations of the moon and planets might be inserted, and approximate ephemerides of Eros and of some of the more interesting asteroids, such as Hungaria, Tercidina, Sirona and Polyhymnia.

It is recommended that these and similar changes be proposed to astronomers, and that they be invited to suggest others, as was done by Professor Newcomb when taking charge of the office.

A series of papers of very great scientific value, entitled 'Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac,' has been issued by this office during the last twenty years. The 'Contribution to Celestial Mechanics,' made while the office was under the direction of Professor Newcomb, was a notable one, and a continuation of the papers mentioned is greatly to be desired. A continued investigation of the motion of the moon is especially recommended.

INSTRUMENTS.

The Board at its meeting in April appointed a committee which made as careful an inspection of the instruments of the Observatory as was possible during the time at its disposal. On the whole, the 26-inch equatorial is in good condition. It is recommended that this instrument be supplied with a micrometer at least equal in quality to that constructed for the large equatorial of the Pulkowa Observatory. Also a good field illumination should be provided, as well as a symmetrical illumination for the wires.

Since the visit of the committee in April a number of improvements have been made on the 12-inch equatorial; a bright field illumination is still needed. An investigation of the object glass, which gives poor stellar images, is now in progress by Mr. King, the officer in charge. This examination will show whether the glass is merely out of adjustment or should be refigured.

Extensive repairs are needed for the 9-inch transit circle, and especial attention is invited to Exhibit B, which gives a list of the most important improvements referred to.

A number of changes have been made in the 6-inch transit circle; these and others still needed are referred to in Exhibit C. For both transit circles collimators should be provided having object glasses of larger apertures, and also better means should be provided for obtaining the necessary meteorological data.

The prime vertical transit should be pro-

vided with a long focus lens and an azimuth mark. The house containing the altazimuth is too small. The present building should be replaced by one of such size that collimators may be placed inside of the dome, and, as in the case of the prime vertical, a long focus lens and an azimuth mark should be provided.

For use with the meridian and prime vertical instruments three new chronographs are needed.

Special attention is called to the importance of a careful study of each instrument of the Observatory and a prompt publication of the results of such investigations.

LIBRARY.

The Library contains 18,025 bound volumes and 3,891 pamphlets. It is devoted to astronomy and mathematics, and the allied sciences, and is particularly rich in complete sets of the publications of observations, academies, and learned societies of Europe, many of which are rare as well as modern treatises and reports of investigations. It is admirably arranged and is in excellent order. The assistant librarian in charge has made considerable progress in the preparation of a comprehensive card catalogue, which will render the material on the shelves much more available.

The appropriation of $750, which is now provided for the Library, is not sufficient for its needs. About $350 of this is required to keep up the scientific journals and the works, such as yearbooks, which appear periodically. The remainder of the appropriation is not sufficient to provide the new books, engravings, photographs, and fixtures required, and to fill up gaps in the Library when special opportunity offers. It is recommended that the appropriation be increased to $1,000.

ADDITIONAL REQUIREMENTS.

In the opinion of the Board, there is urgently needed—

1. A repair shop for the instrument maker.

2. Residences for those who are regularly engaged in late night observations.

EXPENDITURES.

The expenditures for the Naval Observatory are presented in Exhibit D.

From the manner in which the appropriations have been made, it is not easy for the Board of Visitors to determine what portion of the expenditures pertains properly to astronomical work, what portion to naval work, and what portion to the improvement and care of the grounds as a park.

Respectfully submitted.

CHAS. A. YOUNG,
CHAS. F. CHANDLER,
ASAPH HALL, JR.,
E. C. PICKERING,
ORMOND STONE,
WILLIAM R. HARPER.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

THE fifteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held at Washington, D. C., November 12 to 14. President A. W. Harris, of the University of Maine, presided at the general sessions and delivered the president's annual address. This address set forth clearly the more important things for which the land-grant colleges stand and summarized the results of their work. The land-grant act of 1862 was considered important not only as providing for agricultural education, but as the first sufficient recognition of study and investigation as the basis of the best success in the arts and industries. It also proclaimed the duty of the national government to promote industrial education, and in its results demonstrated the effectiveness